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Researches on the Structure, Organization, and Classification of the Fossil Reptilia. Part IX., Section 3. On Diademodon

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XXIII. *Researches on the Structure, Organization, and Classification of the Fossil Reptilia.*—Part IX., Section 3. *On Diademodon.*

By H. G. Seeley, *F.R.S.*

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[Plate 89.]

The South African fossils with broad, flat, tuberculate tooth-crowns of mammalian type are all from the eastern part of Cape Colony. Some of the most interesting are only known from fragments, which indicate nothing but the middle region of the skull. They are apparently extremely rare. Two species, with teeth well preserved, were found ten years ago by Dr. Kannemeyer, at Wonderboom, and presented to the South African Museum, Cape Town, where they were brought under my notice by M. Peringuey. Others were found in a fragmentary condition by Mr. Alfred Brown, of Aliwal North, to the west of that town, in a bed which appeared to me to be reconstructed. There is no doubt that the fossils are from the upper part of the Karroo formation, probably of Permian age, and below the Stormberg beds, in which Saurischian fossils are found allied to those of the Trias of Europe.

If the teeth had occurred isolated, without the means of demonstrating their resemblance to Theriodonts, by comparison of what remains of the skull, it would have been legitimate to have referred them to Mammals. There is no evidence of affinity except resemblances to Theriodonts, which show that the skull had pre-frontal and post-frontal bones, and therefore may be inferred to have had the lower jaw composite. The teeth are such as might be expected, perhaps, in a Monotreme Mammal, and their interest is therefore the greater that there is no ground for suspecting them to be mammalian, other than a general resemblance of the crown to the crowns of the true teeth of *Ornithorhynchus*. That teeth of this type should occur in a group of animals in which the shoulder-girdle and pelvis have monotreme characters, and in which the principal limb bones are intermediate in character between Monotremes and Marsupials, is evidence of a closer approximation between Mammals and Reptiles than has been manifest. And so far as I am aware the only Theriodont characters now remaining to distinguish these animals from Mammals are the composite lower jaw, which is covered externally by the dentary bone along its whole length, and the presence of the pre-frontal, post-frontal, and transverse bones in the skull.

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The genus *Diademodon* is founded on the characters of the molar teeth. They are wider in the maxillary bone than in the mandible, with the crown low, sub-quadrate, or transversely ovate in the hinder maxillary teeth. There are two or three cusps on the internal and on the external borders, with one tubercle on the anterior border, and several tubercles on the posterior border. There is a tubercle in the centre of the crown, which is connected with the principal outer cusp by a transverse ridge, and connected with the two principal internal cusps by one or two ridges. The characters are most marked in the hinder molar teeth, but in the early teeth cusps and ridges are less developed; and the pre-molar teeth are small. The same plan can be traced in the crowns of three or four species which are distinguished by the form of the crown, and modifications of its ridges and tubercles. *Diademodon* may belong to the Gomphodontia.

Diademodon tetragonus. (Plate 89, figs. 1–10.)

In 1884 Dr. KANNEMEYER presented to the South African Museum, Cape Town, some fragments of jaws and teeth of a small animal found near Burghersdorp, which is characterized by having quadrate tuberculate crowns to molar teeth of a mammalian aspect. The materials comprise portions of the right and left maxillary bones, with four molar teeth in sequence in good preservation, and a socket for a fifth tooth is indicated at the anterior fracture (Plate 89, fig. 1). The hard palate extends between the teeth which are preserved. In another fragment are the roots of three pre-molar teeth. There are two isolated teeth, one the crown of a pre-molar and the other probably an early molar; and there are three fragments of compressed fluted canine teeth (fig. 3), and what appears to be a portion of the lower jaw (fig. 4). All of these remains I refer to one individual. From them I have separated teeth which belong to animals of a different type. There is no indication of incisor teeth, which may be presumed to have been present, if the canines are rightly referred to this fossil, for I am not aware that canines and molars are developed in these animals without incisors unless that condition is found in *Tritylodon* (IX. § 2, p. 1025). It seems not improbable that there may have been three small teeth in the position of pre-molars and seven in the position of molars, though the fragments only demonstrate five. The skull may have been three inches long.

The genus *Diademodon*, based upon this species, is defined as having molars of sub-quadrate or transversely ovate form, characterized by flattened crowns, which have the margins crenulate, and the crenulations rising into two or three cusps on the inner and outer borders. These cusps are connected by transverse ridges, which may develop cusps or crenulations. The distinctive character of these teeth is, first, that the elevation of the cusps makes the crown concave from side to side; secondly, that the two principal cusps on the inner side are nearly equal, so that not only is there an oblique ridge crossing from the hinder cusp to the principal external cusp, but there is also, in the principal molars, a short anterior ridge extending from the first inner cusp towards the middle

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of the tooth, on which small longitudinal cusps are developed. These cusps are more or less worn down with use, but, when not so worn, *Diademodon* is distinguished from allied genera by the well-defined elevated anterior and posterior ridges of enamel, which are crenulate, and in some cases slightly cuspidate.

The type species is named *Diademodon tetragonus*, in reference to the form of the under molar teeth.

When the right and left maxillary bones are fitted together, as preserved, they give evidence of some lateral crushing of the jaws, by which the bones of the palate have been a little displaced, sliding over each other. What remains is concavely channelled. The jaws, as adapted, increase in width from $\frac{11}{20}$ inch in front to $\frac{17}{20}$ inch behind, and were manifestly wider apart before the specimen was broken; so that, while the maxillary teeth diverge backward in the usual way, the palate between them was fully as wide as in any of the allied genera. The crowns of the teeth are in close contact with each other, and set close into the jaw, so that the unenamelled area between the cingulum and the thin alveolar margin is very narrow, and only just visible above the bone. The side of the maxillary bone external to the four hindermost molars is flattened, very slightly concave in length, and as slightly convex from above downward. Only about $\frac{3}{10}$ inch of its depth is preserved, and the greatest length of the left maxilla, as preserved, is $\frac{17}{20}$ inch.

On the left side the crowns of the teeth are broken, so that they are not easily compared on the two sides, but apparently the last tooth is lost, and the three in advance are similar in size and character to the teeth on the right side.

The fourth tooth on the right side is imperfectly developed, its crown being on a level with the alveolar margin. There is no space for any root on the inner side, but a small root is seen on the outer side descending through the jaw, and this root appears to be cylindrical. This tooth has the crown slightly wider than the tooth in front, and the width and size steadily diminish to the first of the series preserved. The antero-posterior extent of these four teeth is $\frac{7}{10}$ inch. The width of the fourth is $\frac{7}{20}$ inch, and of the first is between $\frac{3}{20}$ inch and $\frac{4}{20}$ inch. The crowns, with the exception of the first, are a little wider than long, and have the aspect of being four-sided with the angles rounded. This is probably the consequence of the teeth being in contact back and front; and of the inner and outer sides, which are gently inflated and convex, having the cusps so developed as to give the effect of linear extension on the inner and outer margins of the series. The crowns are not all of the same height above the jaw, the first being lower than the second, which is highest, so that the grinding surface is convex from front to back, and the cusps of the inner side are a little higher than those of the outer side, though this probably indicates that the external surface of the maxillary bone, instead of being vertical, was inclined a little outward. The height of the highest point of the second tooth in front is $\frac{3}{20}$ inch above the alveolar border, while the height of the first is about $\frac{2}{20}$ inch. Seen from the external surface, each tooth in which the crown is perfect

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and above the jaw, has a distinct cingulum, which marks the lower limit of its enamel. Above this the side of the crown is moderately convex both from front to back and from above downward; triangular in outline, with a principal cusp in front, and, in the case of the second tooth, with two minor cusps behind. This cutting edge is finely crenulate and sharp, and the crenulations, like the cusps, make minute wrinkles on the summit of the enamel. The minor cusps are defined by slight superior notches and lateral groovings of the enamel on both the inner and outer surfaces. Hence, if the jaws were closed, such teeth would give no indication of the form of the crown.

On the inner alveolar border there are two principal cusps, almost equally developed, with a third smaller cusp behind, though the third cusp does not appear to be present in the first tooth. The principal cusps have sharp cutting edges and are divided from each other by an angular notch. The inner surface of the crown is rather more inflated than the external surface (fig. 2). When the teeth are seen from the palatal aspect each crown is margined back and front by a slightly elevated ridge of enamel. That in front connects the anterior cusps on the inner and outer side by a curve which would be concave except that it develops a small cusp in the middle. The second cusp on the inner side is connected with the principal cusp on the outer side by a strong angular transverse ridge, slightly crenulate on the sharp summit (fig. 2). This ridge divides the crown into anterior and posterior portions. On the middle of its front margin, but not rising above it or from it, is a small cusp; a second accessory cusp by its side rises towards the external cusp, and a short sharp concave ridge, also finely crenulated, extends from the first inner cusp, but does not reach the minor cusps just described. These minor cusps vary a little in the successive teeth. The posterior half of the crown slopes down to the low ridge which margins the posterior border, and thus forms a concavity, defined in front by the minor cusps which follow the principal cusps. Upon the posterior border are four minute cusps, which have a sharp crenulate superior edge; the inner two are a little the larger, and all are of slight elevation.

The general effect of this cuspidate structure is that there is a sharp cuspidate girdle, surrounding the sub-quadrate or sub-ovate crown, with one cusp strongly developed on the outer margin, and two strongly developed on the inner margin; that the tooth is traversed transversely by strong sharp ridges connecting these cusps; and that the minor cusps give the aspect of a median broken ridge running longitudinally down the teeth, at a lower level than the principal transverse ridges.

The teeth show signs of wear, the first molar having all the cusps partially worn down. In the second tooth, the wear only affects the anterior margin; the third tooth is unworn; and the fourth, as already remarked, is not yet fully cut.

With fragmentary remains like these there is more or less of uncertainty in associating the specimens, but the fragment which I have regarded as containing the roots of pre-molars is identical in texture of bone of the palate and of the external

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surface. The fragment belongs to the left side, but something is lost between it and the other fragment of the maxillary bone (fig. 1). The three teeth, indicated by the bases of the crowns on a level with the alveolar margin, occupy rather more than $\frac{3}{10}$ inch from back to front. They rapidly diminish in size anteriorly. The first small tooth is longitudinally ovate, and the third is transversely ovate. The jaw fragment in which they are contained, appears to indicate a rapid decrease in the height of the snout.

There is an isolated tooth, with a fractured root, which is no larger in transverse section than the smallest of these teeth. It is possible that it belonged to the opposite side. It has a strong lateral cusp which I suppose to be external, and a transverse ridge from it in a T-shape, extending to the cusp of the opposite side, and dividing the crown unequally into anterior and posterior parts. The tooth is worn with use, but shows some indication of minor cusps at its front margin.

Evidence of the mandible.—There is a small fragment which I regard as part of the dentary bone of the right side, fractured so as to show two teeth. It is remarkable for the relatively small size of the teeth, which are much narrower than the last maxillary molars (Plate 89, fig. 4) preserved in the bone in *D. tetragonus*.

The fragment of the jaw is too imperfect for detailed description, but appears to show what, I think, may be the origin of the coronoid processes, below which the jaw is excavated as in Theriodonts. If so, the specimen has lost a third of its depth, and would indicate a robust lower jaw. The Theriodont jaw is frequently constricted in its lower part, especially on the inner side, below the roots of the teeth, and such a condition, I suppose, to account for the apparent convexity of the sides of this specimen. The fossil, owing, perhaps, to state of preservation, gives no evidence of the lower jaw being composite; though it has no character which is not Theriodont. The fragment is about $\frac{13}{20}$ inch long, fully $\frac{6}{20}$ inch thick, on a level with the teeth at the base of the coronoid, and as preserved $\frac{8}{20}$ inch deep, which is less than the depth of the penultimate tooth.

That tooth has a long sub-cylindrical root (fig. 5), which tapers somewhat as it descends; and a low crown, which scarcely rises more than a tenth of an inch above the lower jaw, and is slightly convex. The crown is somewhat longer than wide, being $\frac{4}{20}$ inch long, and slightly more than $\frac{3}{20}$ inch wide. Its border is surrounded by small cusps, and there is a transverse ridge as well as a median longitudinal ridge of small tubercles. This tooth appears to be worn on the inner side, so that the principal cusp is removed if it was developed. The last tooth in the jaw is not fully cut. Enough is shown to indicate a strong external cusp with two smaller cusps behind it, followed by a third which appears to be in the median line. The cusps on the inner side are similar, and possibly a little larger. The two principal inner and outer cusps are connected by a transverse ridge, on each side of the middle of which is a considerable tubercle, which helps to suggest the same idea of a cross ornament,

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as in the maxillary teeth. The transverse ridge divides the tooth in the same way into anterior and posterior areas, but the anterior border is not exposed.

The external texture of the bone is marked by parallel ridges very similar to the grain seen in the skull bones of Theriodonts. Owing to the fragmentary nature of the remains there is no direct proof that this specimen is reptilian, and its determination rests upon comparison with other South African fossils. Perhaps the teeth, which most closely resemble it in form of crown, are some of the molar teeth described by Professor MARSH under the name *Ctenacodon*. There is no other approach to a well known mammalian fossil type; though the resemblance is, perhaps, as close to the hinder molars of *Plagiaulax*, of which *Ctenacodon* is representative. Its approximation to the molar teeth of *Ornithorhynchus* in the form of the crown is not less noticeable in the low crown surrounded by tubercles and cusps and crossed by ridges, though the long single root is an interesting difference of type. The crowns of the molar teeth are not less mammal-like than those of *Tritylodon*, though the arrangement of the tubercles is different.

The smaller size of the mandibular molars is probably a generic or family character of *Diademodon*, and may account for a maxillary tooth in another species *D. Browni*, which is worn with use, having the external and internal cusps still prominent, while the middle of the crown is concavely excavated.

There are two isolated wide molar teeth of the left side, found at the same time by Dr. KANNEMEYER, which possibly indicate a second species, though they may be the hinder molar teeth of *D. tetragonus*.

The teeth are of similar size, $\frac{4}{10}$ inch long, with low crowns between $\frac{4}{20}$ and $\frac{5}{20}$ inch wide, with the first measuring $\frac{3}{20}$ inch from front to back, and the second slightly longer. The crowns (figs. 6, 9) are transversely ovate in section, and the roots are compressed, tapering to a wedge form by front to back compression, and also becoming narrower from side to side towards the basal termination (figs. 7, 10), which is not quite perfect (fig. 8). The fracture shows that there was a pulp cavity. Towards the base of the root there is a longitudinal groove in the middle of each side in one specimen, but no indication of a terminal division of the root (fig. 8).

The enamel of the crown extends evenly round the tooth (figs. 10, 7) which does not suddenly contract below it. The external and internal cusps are prominent. On what I suppose to be the outer side there is a principal cusp rising in a triangle with a secondary cusp on its hinder border, and on the inner side there are two cusps of nearly equal elevation, only slightly divided.

These cusps are connected by anterior and posterior ridges, with a single tubercle in the middle of the anterior ridge (figs. 6, 9), and several crenulations along the posterior ridge. Both these ridges form sharp cutting edges. The central part of the crown is occupied by a longitudinal convexity or low ridge which extends transversely across it. Its posterior side is diversified by a tubercle or two, and on the anterior side there are several fine elevated folds of enamel, one longitudinal and another

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transverse, indicating a structure which is substantially the same as that seen in the teeth from Aliwal. The minor folds of enamel probably vary with every tooth in the series as in the teeth of mammals, for these two molars present some differences in detail. The central convexity which is a feature of the teeth of this species, both in the lower and upper jaws, is much less prominent than the external and internal cusps which it connects together. In the event of this proving a distinct species it may be known as *Diademodon brachytiara*.

Diademodon mastacus. (Plate 89, figs. 11, 12).

Among the specimens entrusted to me by Mr. Alfred Brown is a portion of a left maxillary bone (Plate 89, fig. 11), with the adjacent elements of the skull so far preserved as to give its contour; and it indicates sockets or crowns of eight molar teeth. It gives evidence of a head which was probably not less than 5 inches long, and $2\frac{1}{4}$ inches wide at the back of the orbit; with the skull flattened above, and the maxillary bones nearly vertical.

The fragment as preserved is $1\frac{9}{10}$ inch long. It is fractured, so that the nasal bones are not seen, and so as to show a median vertical plate dividing the posterior nares. The palate, in front, is formed by palatal plates of the maxillary bones, which unite in a median suture, forming a hard palate; and the lateral border of palatal plate excavates the maxillary bone. Its inner alveolar margin forms a vertical wall against the teeth (fig. 11), which is thin, and defines the dentary tract; posteriorly it may be replaced by the palatine. The state of the specimen does not permit detailed description of the orbit, or other areas, though the orbit appears to extend as far forward as the penultimate molar tooth, and to be lateral and nearly vertical. The vertical maxillary bone, as preserved, exceeds an inch in depth, is concave from front to back, has a distinct rounded ridge above the posterior molar teeth, which descends a little as it extends backward, but does not appear to become much elevated, though it renders the bone between it and the orbit somewhat concave. The maxillary bone is traversed by a large internal vacuity, shown in the anterior fracture. The jaws converge forward, but there is no appreciable convergence of the maxillary bones upward, though the vertical contour is slightly convex. It is not possible to define either the lachrymal, or the pre-frontal bone, and there is no portion of the frontal or nasal surface preserved. Yet these imperfect indications show a family relationship between this specimen and others which are better preserved, sufficient I believe to determine its organic relations.

The teeth are, perhaps, more interesting than those in any other fossil, on account of the remarkable development of low cusps upon the transversely oblong flattened crowns. The first tooth preserved, which is only indicated by a portion of the socket, is the smallest. The roots of succeeding teeth are in distinct alveoli, are transversely ovate, almost in contact with each other at the base of the crown, and have ovate

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pulp cavities, shown in the three teeth succeeding the first socket, from which the crowns have been broken away.

Then follow three crowns in fair preservation, behind which is a space covered with matrix, which probably contained a small molar not yet cut.

Two of the crowns which are best preserved show that the cusps were worn with use (fig. 12, *b*, *c*). The size of the crown appears to augment to the fourth or fifth of the series, of which the specimen gives evidence (fig. 12, *c*), and then to diminish to the end of the series. The elevation of the crown was probably greatest in the middle of the series, so that in a longitudinal direction the crowns were convex from front to back, as is frequently seen in the maxillary teeth of Mammals and Theriodonts. In this fossil the part of the crown which rose above the gum has the enamel of a rich orange-brown colour, traversed by numerous vertical cracks, while below this transverse line the enamel is white. The transverse width of the root of the fourth tooth indicated is $\frac{4}{10}$ inch. The antero-posterior extent of this tooth is $\frac{5}{20}$ inch. The antero-posterior extent of the three fractured roots (fig. 11) is $\frac{13}{20}$ inch, and the transverse width of the first of the three is $\frac{3}{10}$ inch.

The three crowns preserved (fig. 12) vary in size, aspect, and in preservation. The first (*c*) is $\frac{4}{10}$ inch wide and $\frac{3}{10}$ inch from front to back. The second (*b*) is $\frac{7}{20}$ inch wide and $\frac{5}{20}$ inch from front to back. The third crown, which is imperfectly exposed (*a*), is $\frac{3}{10}$ inch wide and less than $\frac{5}{20}$ inch from front to back. Owing to wear of the cusps, their original form is not so evident as the position of the cusps, but it is manifest that the cusps are arranged in two series, internal and external.

The external cusps are two in number (fig. 12), a large anterior cusp, adjacent to a smaller posterior cusp, and both apparently worn down so as to be connected together like a figure eight (8). The inner side of the tooth is more rounded from front to back. Here there are three smaller cusps, which increase in size from behind forward. The posterior border between these anterior and posterior cusps is concave superiorly, and occupied by about five minute cusps in the first crown preserved (*c*), but the number appears to be smaller in the subsequent teeth, though the border is not fully exposed. The anterior margin of the tooth is also concave on its superior surface, and appears to be occupied, as in the other species, by a single small cusp, which is not much worn.

These cusps, upon the inner and outer sides of the teeth, give off transverse crenulated ridges; which extend from the cusps upon the anterior and inner borders towards the anterior cusp on the external border. From that cusp a ridge descends towards the cusp opposite to it on the inner border, which has the effect of dividing the crown into anterior and posterior areas. All these ridges are low, and their effect is to make a division of the space between the cusps into three areas, first, a large area posterior to the first external cusp and second internal cusp; secondly, an anterior area enclosed by the transverse ridges upon the crown, which include some connecting bars; and, thirdly, the small anterior area which slopes from the anterior ridge to the anterior cusp.

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It is possible that the teeth of this species may not be separable from those of *Gomphognathus*. There is nothing with which these teeth can be compared except the molars of some of the higher groups of Mammals. It may be convenient to state that the specimen is not referred to the Mammalia because, first, its teeth have but one root, though this character appears to be less important from the reputed double roots in *Tritylodon;* secondly, the crowns can be shown to be a modification of the crowns in genera in which the post-frontal bones preserve their individuality, and the skull, in essential points, is Theriodont and not Mammalian.

Nevertheless, the border between the two groups, Mammals and Reptiles, appears to be closely approached when the dentition exhibits the complexity of cuspidate crowns found in this fossil, to which no Reptile has made a closer approximation than the genus *Teius*, in which I have figured internal and external cusps of a simpler type than this fossil shows ('Roy. Soc. Proc.,' 1888, vol. 44, p. 139). In that genus of Lizard, there are no accessory lateral cusps or connecting ridges, except the one ridge which unites the one internal cusp to the one external cusp. The lower jaw, which is always made of several bones in Theriodonts, is not known in this fossil, or in *Tritylodon*. The transverse bone of the Theriodont palate is not shown, for that region of the skull is not preserved. The reptilian nature of these teeth is further evidenced by the structure of the skull in *Diademodon Browni*, and in *Gomphognathus*.

Diademodon Browni. (Plate 89, figs. 13, 14).

In Mr. Alfred Brown's collection from Aliwal North, is the middle portion of the skull, fractured transversely back and front, showing the palate, and sockets or roots of molar teeth, and one molar with a crown well preserved, but worn down with use. At the transverse fracture in front, the skull is slightly distorted by lateral compression, and measures $1\frac{1}{10}$ inch from the palate to the roof of what is presumably the nasal region. The transverse width, which is reduced by lateral compression, is $1\frac{4}{10}$ inch.

The skull is flattened above, nearly vertical at the sides, though generally a little convex from above downward, and concave from front to back.

The head widens as it extends backward to the orbit, the upper anterior border of which is $2\frac{1}{10}$ inches wide. At the posterior fracture, which is behind the dentary tract, the width indicated is $2\frac{7}{10}$ inches, so that in a length of two inches the width of the jaw is doubled by posterior divergence of the alveolar areas. The posterior fracture passes through the frontal and post-frontal bones, which are both thick, the former exceeding $\frac{3}{10}$ inch, and the latter measuring $\frac{1}{2}$ inch deep on the hinder border. The superior border of the orbit is well preserved on the right side only. The transverse width between the orbits appears to have been $1\frac{1}{2}\frac{1}{0}$ inch. As in so many of these skulls, the post-frontal bone has its inner border raised above the pre-frontal bone, along the line of contact. The transverse width of the frontal

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interspace between these bones does not appear to have exceeded $\frac{7}{20}$ inch; the longitudinal width of the post-frontal, from front to back—from the orbit to the temporal vacuity—appears to have been nearly $\frac{1}{2}$ inch. At the posterior fracture, the elevated hinder borders of the post-frontal bones are converging, as though they would contribute to form a narrow crest between the temporal vacuities, as in most genera of the Theriodont group. There is a very slight median ridge on the frontal bone, extending longitudinally forward. The pre-frontal makes the superior border of the orbit in front. Below that bone is the lachrymal, though its limits are not clearly defined. The length of the pre-frontal is $1\frac{7}{20}$ inch. There is no clear indication of the anterior limit of the frontal bone, though it may not extend further forward than the orbit. The median suture is distinct between the nasal bones, but the transverse suture between the nasal and frontal is less evident. The maxillary bones form the lateral wall of the jaw, but do not appear to extend far upon its upper surface.

A longitudinal concavity (fig. 13) extends in front of the orbit, below which there are somewhat large foramina, $\frac{4}{10}$ inch above the alveolar margin, situate upon the convexity which extends longitudinally upon the lower part of the external surface of the maxillary bone.

The transverse width of the palate is less than that of the pre-orbital roof of the head, owing to the lateral convexity of the maxillary bones. Its transverse external measurement over the teeth at the anterior fracture is 1 inch, and the indicated transverse measurement at the last tooth is $2\frac{3}{10}$ inches.

The teeth are closely parallel to the external alveolar border. They increase in size from the front backward as far as the sixth, on the right side, beyond which there appear to be indications of three teeth on that side of the jaw, judging from the space between the alveolar ridges, which is occupied by matrix. On the left side, the first of the teeth indicated on the right side is not preserved, but eight teeth are indicated by fractured roots, from which the crowns are lost, or by sockets which are defined by the curvature of the alveolar margins. The palate between the teeth has already been referred to as vaulted. Its width in front is $\frac{6}{10}$ inch. It widens about $\frac{1}{10}$ inch opposite the sixth tooth of the series preserved, where the anterior border of the posterior nares forms a concave transverse contour, truncating the hard palate. Below and behind this the posterior extension of the palatal bones, presumably palatine, forms a V-shaped cranial roof to the palato-nares.

The transverse width of the teeth augments from $\frac{2}{10}$ inch in the first preserved, to more than $\frac{7}{20}$ inch in the sixth. The teeth are transversely ovate, but this character is less marked in the earlier than in the later teeth. No tooth shows an empty pulp cavity, though in the small pre-molar teeth the cavity apparently exists The width of the fractured base of the crown of the sixth tooth on the right side is almost $\frac{4}{10}$ inch, and its antero-posterior extent is less than $\frac{5}{20}$ inch. This is approximately the measurement of each of the teeth from the fourth to the eighth.

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The longitudinal extent of these five teeth and sockets appears to be $1\frac{1}{10}$ inch. The external side of the tooth shows no appreciable indication of being wider than the internal side, as in so many mammals.

The solitary crown on the right side, which I have termed the sixth in the jaw, I should regard as probably the fourth molar, and therefore conclude that the jaw contained seven molar teeth, and gives evidence of at least two pre-molar teeth with nearly circular crowns. The fractured bases of the fifth and sixth crowns are in close contact with each other. Other evidence shows the border of the socket to have been extremely thin.

The crown is low (fig. 14), and the entire surface which projects above the bone is enamelled. Below the alveolar margins the enamel, which is convex all round, ceases, without any manifest contraction in the dimensions of the crown. The tooth is greatly worn with use, so that its original surface and structure cannot be inferred from its present condition. The wear, however, has not obliterated the evidence that there was a large anterior cusp on the external border, succeeded by two very small cusps, continuous with minute cusps which extend along the posterior margin of the tooth, though they are worn away from its inner half. On the inner alveolar side there was a large anterior cusp, succeeded by a smaller posterior cusp, the small development of which gives to the tooth a slightly compressed aspect on its hinder inner side. A ridge appears to have extended transversely from side to side between these cusps. The tooth is therefore somewhat intermediate between types like *Diademodon* and *Trirachodon*. It is entirely distinct from anything otherwise known to me, and is probably the type of a distinct genus. It is distinguished from the tooth of *D. mastacus* by the *posterior* accessory cusps.

I regard the clear definition of the post-frontal bones as convenient ground for grouping the genus with the Reptilia. The pre-frontal bones are equally well-defined, and the suture seems to me to be distinct which marks the anterior limit of this bone and separates it from the lachrymal. The evidence of skull structure shown in this specimen is important in relation to the resemblance of the isolated tooth crown to the teeth in the jaws previously described.

I desire to express my sense of the services rendered to science by the gentlemen who collected these fossils, and especially to Mr. Brown, for personal kindness in showing me the sections near Aliwal North, and for the loan of specimens; to the Trustees of the South African Museum for the loan of fossils collected by Dr. Kannemeyer; to Her Majesty's Principal Secretary of State for the Colonies, Lord Knutsford; and to the Government Grant Committee of the Royal Society in 1889, for assistance.

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Explanation of Plate.

PLATE 89.

Fig. 1. Palatal aspect of fragments of jaws referred to *Diademodon tetragonus*, showing anterior molar teeth, without indication of posterior truncation of the hard palate. Natural size.

Fig. 2. Three right molar teeth of this specimen, enlarged four times, indicated as *a*, *b*, *c*, showing details of the cusps.

Fig. 3. Fluted canine tooth found with the specimen shown in fig. 1. Enlarged three times. Possibly referable to the same species.

Fig. 4. Posterior fragment of the right mandible, showing the crowns of mandibular molars, referred to the same species. Enlarged three times.

Fig. 5. Molar tooth, showing the conical form of the root, and its relation to the crown; the same species. Enlarged three times.

Fig. 6. A crown of the left molar tooth, provisionally referred to *Diademodon brachytiara*, but possibly a posterior molar of *D. tetragonus*.

Fig. 7. Posterior aspect of the same tooth, showing the root somewhat crushed, giving an illusory appearance of longitudinal division.

Fig. 8. Outline of the broken extremity of the root of this tooth, showing the pulp cavity, without any trace of division of the root.

Fig. 9. A crown of another left molar tooth of the same species.

Fig. 10. The posterior aspect of the same tooth, showing an appearance of longitudinal grooving of the root, which is due to compression and fracture. Figs. 6 to 10 are enlarged four times.

Fig. 11. Part of the left maxillary region of *Diademodon* (or *Gomphognathus*) *mastacus*, showing the transverse forms of the roots and tubercular condition of the crowns. Natural size.

Fig. 12. The three teeth lettered *a*, *b*, *c*, in fig. 11. Enlarged three times, so as to show the elevation of the external cusps, as in the jaw of *Gomphognathus*.

Fig. 13. Palatal aspect of the middle portion of the skull of *Diademodon Browni*. The way in which the teeth on the right side are enlarged as they extend backward may be compared with the condition shown in fig. 2 in *Diademodon tetragonus*. Since it is manifest that other teeth extend behind these, and behind the hard palate, it is probable that all the three teeth shown in the *D. mastacus* are posterior to the crowns preserved in *D. Browni* and *D. tetragonus*. If the teeth of *D. tetragonus* extended backward they might assume the characters shown in the teeth provisionally termed *D. brachytiara*. Natural size.

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Fig. 14. The crown of the sixth tooth of the right side of *Diademodon Browni*, seen from the palatal aspect, enlarged three times, showing the partial obliteration of the cusps with wear.

Fig. 15. Skull of *Tritylodon longævus*, seen from above, showing what are regarded as the post-frontal bones forming a crest behind the orbit, and the pre-frontal bones above the orbit, margining the frontal bones. Natural size.

Fig. 16. Anterior part of the skull of *Trirachodon Berryi*, figured for comparison with *Tritylodon*, showing the pre-orbital constriction of the maxillary bones, and their sub-orbital transverse expansion; and the post-frontal bones behind the orbits. Natural size.

Fig. 17. Posterior aspect of a Theriodont carpus found isolated at Lady Frere. Half natural size. It is figured from the posterior aspect. There are three bones in the proximal row. The pisiform bone is indicated by the letter *p*. The middle bone is regarded as the cuneiform. The large third bone, which is nearly as wide as the other two, is regarded as scapho-lunar. The central bone, below the cuneiform, has an expansion on its posterior side which resembles that of the bone marked *h* among the central bones, in the carpus of *Theriodesmus*.

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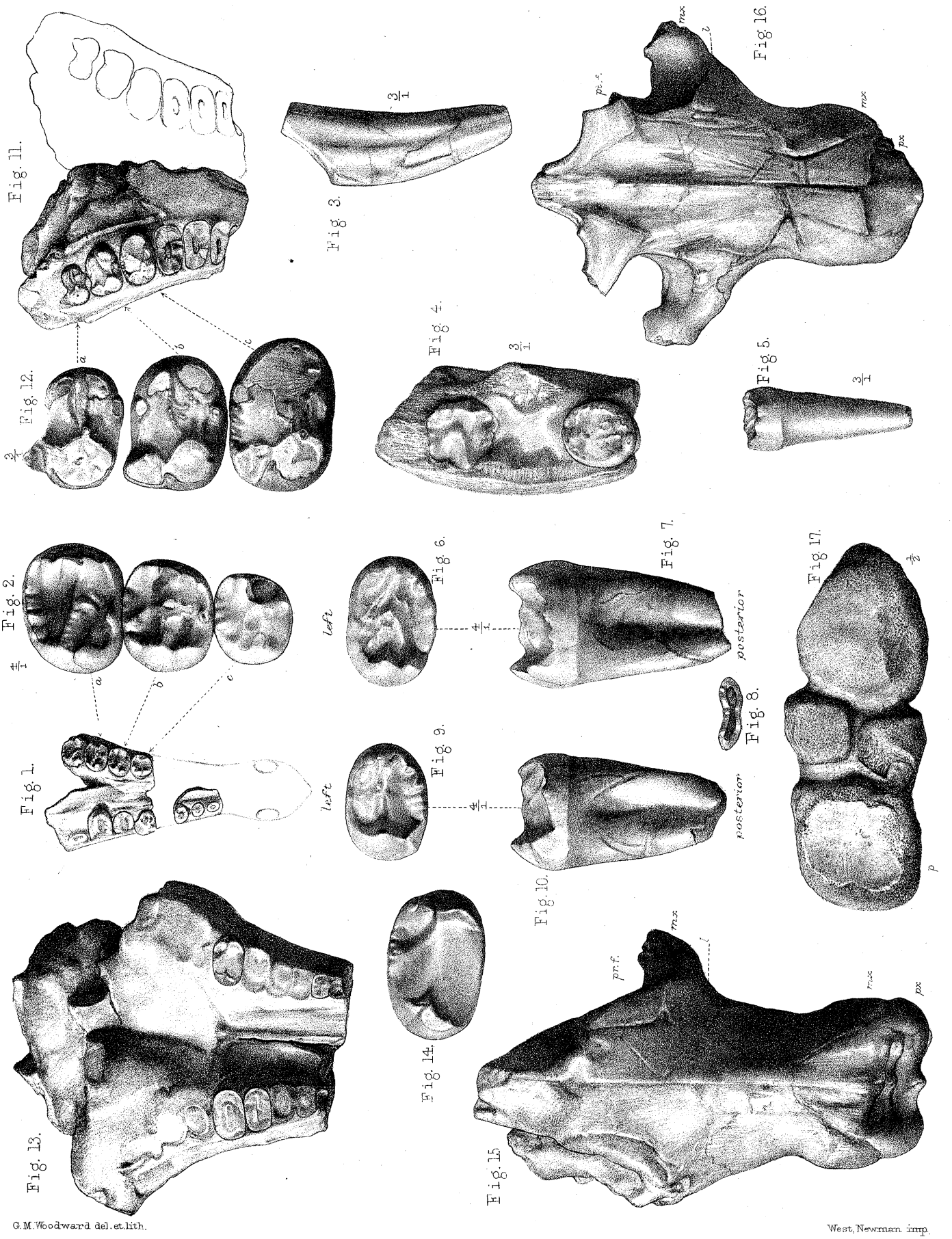

G.M.Woodward del. et lith.

West, Newman imp.

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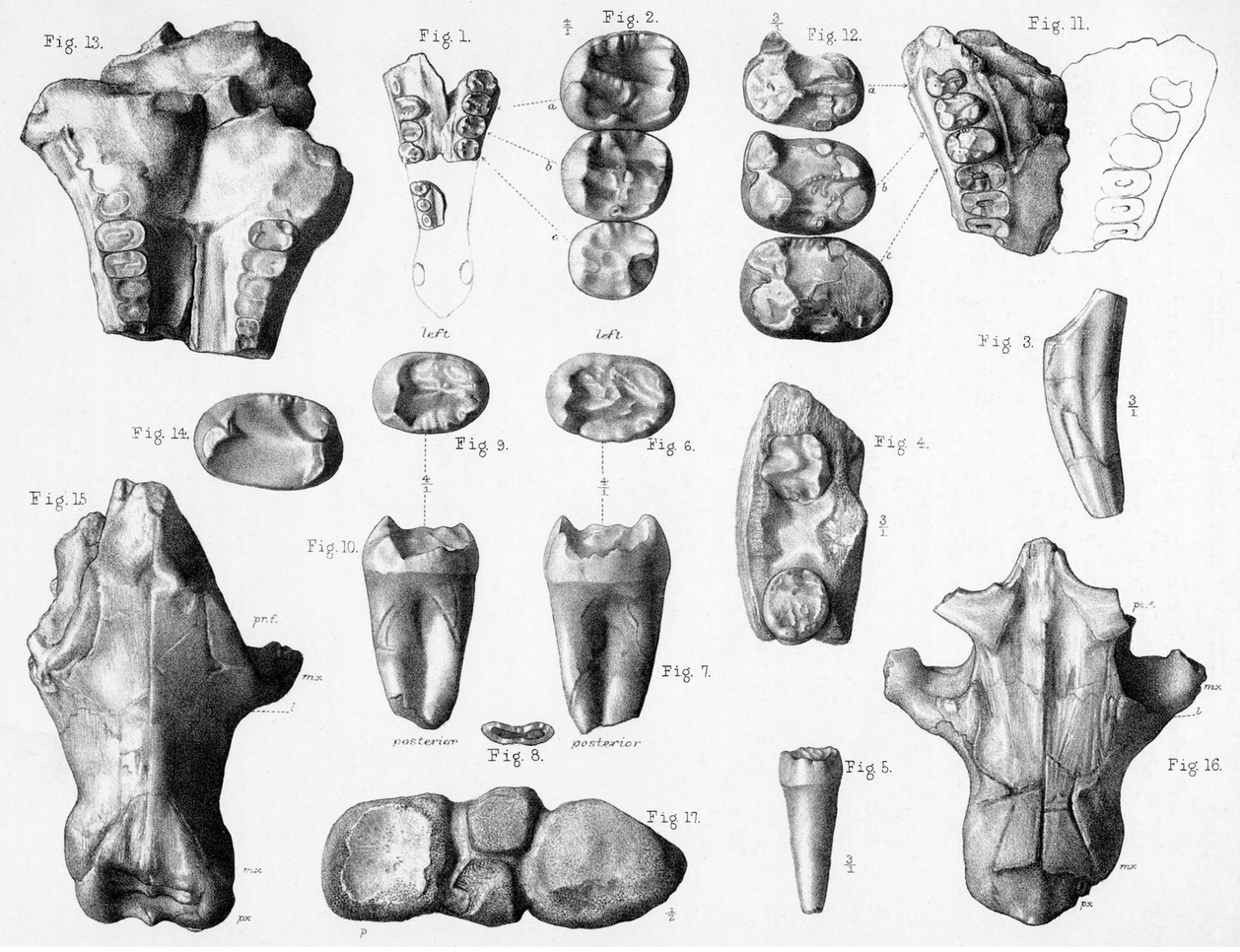

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